Axial Flow-Induced Vibration of a Corrugated Cylinder

Yaron Perets
Department of Mechanical Engineering
Ben-Gurion University of the Negev, Beer-Sheva, Israel

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Abstract:

When a structure is exposed to a flowing fluid it may oscillate as a result of the interaction between the fluid forces and the structure. The interaction between flowing fluids to bluff structure where the flow is the source of excitation of the structure is known as Flow Induced Vibration (FIV) phenomena. There are many features and aspects related to FIV that affect industrial applications such as: civil construction for instance cooling tower, chimneys and bridges, aeroelastic instability of aircraft wings, heat exchangers, pipes conveying fluids, drill string in the oil industry and nuclear reactor components. In the Next Generation Nuclear Plant (NGNP), achieving a high temperature reactor core is one of the ways to obtain high efficiency thermohydraulic performance, which results to high temperature rod cladding. One of the ways to reduce the high cladding temperature is to improve the heat transfer by augmenting surfaces with artificial roughness with repeated ribs. This study focuses on the dynamics characteristics of a flexible cylindrical structure covered by transverse repeated rib roughness and subjected to axial flow. The effects of the repeated rib roughness parameters, such as pitch-to-height ratio \( \frac{p}{e} \), on the characteristics of the rods’ dynamics were examined at low and high flow velocity, both experimentally and theoretically. Experiments were carried out on vertical clamped end flexible silicon rods with smooth surface or that contained repeated rib roughness along their length. Linear equation of motion of the rod under uniform axial flow is formulated in dimensionless terms for parametric investigation of the effect of the rib dimensionless geometry. Based on the linear equation a straightforward nonlinear equation was derived assuming the rod centerline to be extensible.